Summary of FHWA International Scanning Program
For
Pavement Preservation
France, South Africa and Australia
July 6 – 22, 2001

BACKGROUND

Traditionally, highway agencies have allowed the ride quality and structural condition of their pavements to deteriorate to fair or poor condition before taking steps to rehabilitate the pavements. The aim of rehabilitation is to repair structural damage and restore measurable pavement conditions such as ride, rutting and cracking. This is a costly and time consuming activity with associated traffic disruptions and inconvenience to adjacent businesses and residences. In recent years, an increasing number of highway agencies have found that applying a series of low-cost pavement preservation treatments can extend the service lives of their pavements. This translates into a better investment and increased customer satisfaction and support.

France, South Africa and Australia were identified as nations that have innovative programs as well as new treatments for pavement preservation.

OBJECTIVES and PANEL COMPOSITION

The objective of this scanning tour was to review and document innovative techniques, materials, procedures and equipment utilized in the host countries relative to pavement preservation and to evaluate these elements for potential application in the United States. To this end, the panel had meetings with government agencies and private sector organizations involved with pavement preservation, and also participated in site visits to observe the results of pavement preservation techniques and strategies.

The Federal Highway Administration (FHWA), an agency of the U.S. Department of Transportation, and the American Association of State Highway and Transportation Officials (AASHTO), jointly sponsored the Pavement Preservation International Scanning Tour. The delegation included members representing state departments of transportation in Georgia, Michigan, Pennsylvania, and Texas; National Association of County Engineers (NACE); FHWA; National Parks Service; American Public Works Association (APWA); and, from the private sector, Koch Materials Company and Kristen Betty and Associates.

KEY FINDINGS

The countries visited were very thorough in their preparations for the scanning team's visit and were very generous in sharing their experience and expertise. Based on discussions with the host countries, the team recorded many general observations and documented what the team called Key Findings – actions taken that have a marked impact on pavement preservation activities and program success. The Key Findings were categorized in the same topic areas as the amplifying questions sent to the hosting

agencies prior to the team's visit. The team's Key Findings are outlined below by topic area and country.

Management Perspective and Policies

All the countries visited have made a commitment to design and build long lasting structural pavement sections on their national roadway networks. This decision has caused all of these nations to focus maintenance activities on surface courses in order to preserve the large investment in the underlying layers. This, in turn, promotes the use of relatively low cost seals and thin overlays as the primary maintenance techniques, instead of more costly types of rehabilitation.

France

- As noted above, the French government has made a conscious decision to design and build extremely durable, long lasting structural pavement sections (which include surfacing, base, and subbase materials) on the Motorway System.
- Every five years, a comprehensive road investment plan is developed for France's entire road system.

South Africa

- The South Africans, like the French, also build robust structural sections with a long service life into their national network. The methodology is quite different, however. In the Republic of South Africa, roadway sections are constructed of cement treated subbase covered by high quality crushed aggregate base course. The total thickness of these layers is typically 1-1.2 m. The final layer is a thin asphalt section of 30-50 mm. In France, the bituminous layers are considerably thicker.
- A rolling 5-year road improvement plan is developed each year using Pavement Management System (PMS) data and funding optimization strategies. Consequences of various funding scenarios are evaluated and a program is selected that maximizes road condition at a total program cost within the budget available. Potential savings for vehicle operating costs (VOCs) are also included in the optimization analysis, but user costs are not.
- PMS has been used effectively to justify increased funding available for road maintenance and preservation. Simple but clear presentations of network analyses and maintenance needs have been made to local and national politicians. These presentations have been very successful in obtaining additional pavement preservation funds.

Australia

- Australia uses long-term maintenance contracts (10 years), turning over total control and responsibility for roadway system maintenance, rehabilitation, and capital improvements to private contractors are being utilized. These contracts are performance based and require a set of standards to be met. Standards include roughness, texture, rutting, skid resistance and remaining service life. These standards are measured and established at the beginning of the contract and monitored during the contract. Contractors are prequalified prior to submitting a contract proposal.
- Asset Management programs for pavements have been used as effective methods in determining maintenance needs and increasing funding. Australian States have realized the importance of asset management for two reasons. First, asset management provides information and data that enables the state transportation

authorities to better manage their systems. Secondly, it provides a means to demonstrate to management the importance of and needs for additional funding for their road assets.

Resource Commitment and Cost-Effectiveness

France

?? The maintenance focus is on the wearing course. By providing initial high structural capacity, emphasis is placed on protecting the structure using relatively low cost seals and thin overlays on a 7 to 10 year cycle. This also allows for a focus on maintaining good surface characteristics such as high grip (skid resistance) and reduced noise.

South Africa

?? Distress definitions for PMS are very conservative (i.e. severe crack threshold above 3 mm). This focuses maintenance intervention early in the pavement life cycle. In so doing, a higher percentage of relatively inexpensive techniques are utilized to keep water from the base structure.

?? A very high percentage of PMS selected projects are scheduled for implementation (80-90% for the National system). This is achievable because pavement management is accepted at the National level and by some maintenance communities at the Provincial levels. This allows for network conditions to be optimized to as high a degree as funding will permit.

Australia

?? Australia has tried to maximize operational efficiency and cost-effectiveness in the execution and implementation of maintenance works. This was initiated in part due to national policy requirements that mandated competitive procedures. This is accomplished differently in some of the states. Queensland, New South Wales and Victoria all have retained “in-house” maintenance capabilities to some degree. They have complied with the national policy by requiring their own forces to meet competitive requirements such as pre-qualification of skills or tendering offers to perform work. In Western Australia, maintenance operations are competitively negotiated with private contractors. This has resulted in a 7-17% savings for performing maintenance activities relative to benchmark estimates. Estimates assume that work will be performed at or above current standards. Ten-year contracts have just been initiated.

?? Pavement management strategies for allocating maintenance resources vary by state according to state perception of user needs. In more urbanized areas, roughness and functional considerations, such as ride and noise abatement, drive project selection in the pavement management systems employed. In more rural areas, structural considerations are emphasized. In Queensland in particular, the age of surface seals is modeled in PMS and used as the primary predictive trigger for reseal applications. Modeling is based on empirical as well as mechanistic analysis.

?? For most states, rehabilitation is a minor portion of their maintenance program. Pavement preservation techniques are emphasized. This is in part due to budget constraints that require low cost treatments in the early stages of pavement life. For example, in Victoria, typically 90% of the annual maintenance budget is committed to preservation while 10% is committed to rehabilitation.

?? Operating costs for vehicles are used in cost modeling for PMS in most states. This drives treatment selection toward those measures that reduce operating costs, such as improved smoothness.

Treatments, Techniques, and Performance

All three countries use only quality materials for both bitumen and aggregate. Generally, crushed granite and proven polymer-modified asphalt binders are used. This is ensured through the use of very rigorous specifications. Materials sources are specified and there is no inhibition to using sources a great distance away from the project site.

France

?? The primary preservation treatment on high volume roadways is mill and inlay. Often, a high modulus asphalt mix that has proven to be rut resistant (limited to a penetration grade 10/20) is incorporated into the projects.
?? Due to the non-availability of HMA, cold asphalt concrete has been used extensively with good success on low-volume roads as a riding surface (75 mm to 100 mm). The cold asphalt concrete mix process focuses on achieving good coating of the aggregates.

South Africa

?? South Africa makes extensive use of chip seals. Well-established and standardized guidelines are used based on research and practical experience. Chip seals are routinely used on routes with 50,000 ADT or higher. PMS has verified that surface seals are effective treatments for preserving pavement life.
?? It is not unusual for an HMA overlay to be immediately covered with a chip seal.

Australia

?? All the states visited use a treatment called geotextile-reinforced sprayed seal (Technical Bulletin 38). The construction sequence involves spraying a tack coat, placing the geotextile, and then applying a chip seal on top. Information was presented showing that this treatment reduced reflective cracking. In Victoria, 12 to 15 years of performance is expected from this treatment. Typically a crumb-rubber bitumen or conventional bitumen is used for these seals.
?? The technique of pre-coating aggregates for chip seals is used throughout Australia. This practice prevents or reduces the loss of aggregates on chip seals.
?? All the Australian States make extensive use of polymerized asphalts. Considering the heavy and large amounts of trucks using rural roads, the states believe there is a need for the best performing bitumen possible. SBS type polymers are predominately used in their bitumens (at twice the rate used in the United States) for both HMA and chip seal applications.
?? Crumb rubber modifier (15-20%) is used in bitumen for chip seals. This has been effective in reducing reflecting cracking.
?? Even when using full depth HMA pavements, a chip seal is placed on the base material (or subbase) before the asphalt layers are placed. This prevents moisture infiltration or capillary action.
?? New South Wales has been successful in placing thin (40-60 mm) asphalt overlays on concrete by placing hydrocarbon curing and tack coat before placing the overlay on the concrete.

?? A chip seal system is used in New South Wales that applies a layer of bitumen, then a layer of 75 mm fibers, another layer of bitumen and finally, aggregate. This is done to prevent reflective cracking.

Innovative Methods, Practices, and Procedures

France

?? Warranties are used in contracts when applying preventive maintenance techniques which are four years in duration. The functional properties warranted are friction, rutting, and smoothness. The responsibility of the contractor for the repair of non-compliant sections reduces with time and traffic. A secondary effect of the application of warranties has been the innovation of materials and mixtures by contractors and material suppliers. In most instances, the contractors are vertically integrated so the innovation takes place within the company.

?? A system exists, named the "Charter of Innovation," by which the government and industry share in the risk of experiments to develop new and innovative products. RFPs are issued annually for new products and test sections are constructed. Surveys are conducted and the company and the government share in the cost of them. Successful products are then accepted nationally for inclusion in the preventive maintenance program.

?? A process has been developed by a contracting firm that incorporates vegetable oil in a 70-100 pen bitumen, some of which has been modified. This is called a bio-binder. The objective has been to produce an emulsion that is safe, (handling temperatures), environmentally friendly (renewable resource, non-solvent based) and has the necessary technical properties to perform. The first experimental section was built in 1997 and 7,000,000 square meters were placed in 2000.

South Africa

?? A stress-in-motion device to measure contact stresses in vehicles has been developed and is in regular use.

?? A crack activity meter (CAM) has been developed to measure reflective cracking potential and the need to restore the surface before placing an overlay. The meter can measure both horizontal and vertical movement simultaneously, fits between the dual wheels of a test vehicle, and data is captured and processed electronically.

?? The South African National Road Agency Limited has developed a Fitness-for-Purpose Certification system for bituminous products that allows for the early implementation of innovative and proprietary products not covered by existing standards. The program provides potential users with a scientifically sound basis for their decisions on whether or not the product would be fit for its intended purpose.

Australia

?? In New South Wales, sandwich seals with two-coat geotextile reinforced treatment have resulted in an acceptable performance (no reflective cracking) for 11 years.

?? In New South Wales, a pavement condition survey vehicle called Road Crack? has been developed to detect cracking on the pavement surface. This vehicle is more sophisticated and superior to currently available vehicles. Funding is currently being sought to develop and market this vehicle.

RECOMMENDATIONS

The scan team was provided with a wealth information at the formal presentations, during informal discussions and gatherings, and in written documents and materials. Throughout the tour, the team members discussed their perceptions of what they were learning in the context of what techniques and strategies in use by the host countries could be practically and successfully put into place in the United States. The team members met at the end of the tour to review their findings and developed the following recommendations that may have a potential for implementation in the United States.

Deep Subbase, Deep Base, and Extended Pavement Design Life

Recommendation: Demonstration projects with deep subbase and deep base designs be initiated in different regions of the United States to determine the effectiveness of this design strategy.

As a first step, a seminar presenting the experience of South Africa and Australia with these design concepts would be of value. A second step would be to develop a pool fund study to design and construct these demonstration sections with a companion NCHRP project to monitor the long-term performance. These sections should also be integrated with other recommendations in this report for thin surface treatments, including chip seals. Treatments outlined in the **Chip Sealing** section should be incorporated into these demonstration projects.

The countries visited had made decisions to develop pavement sections that included long-lived pavements. These pavements consist of deep subbase and deep base sections with a thin, high-quality wearing course, to provide a good riding surface and moisture protection for the base. Pavement maintenance activities mainly consist of periodic thin surface treatments to renew the ride quality and reestablish an impervious layer. This allows for the maintenance investment to be directed to less expensive surface treatments and not toward costly rehabilitation activities.

In addition, for major sections of the interstate highway system beyond the 20-year design life, it is recommended that consideration be given to design utilizing deep subbase and deep base sections, to provide 30 and 40-year design life.

Chip Sealing

The following innovative procedures and applications have a high probability of improving performance of chip seals in the US.

Although chip seals are commonly used in the US, two of the countries visited (South Africa and Australia) have developed innovative design procedures and application techniques that are not commonly used in the US. Performance lives up to 15 years are being achieved on sections with up to 60,000 vehicles per day. This outstanding performance is due in part to the deep-strength pavement designs employed.

Recommendation: Agencies include pre-coating of chips in their chip seal specifications.

Pre-coating of aggregates will improve the adhesion of chips to the binder. The South Africans use this technique on their highest volume roads with good success.

Recommendation: Geotextile-reinforced chip seals be tested and evaluated in both freeze and no-freeze environments.

Throughout Australia, a treatment called geotextile-reinforced sprayed seals has been very successful. The treatment, which involves tack coating the existing pavement, spreading a geotextile, and capping with a chip seal, is used on roadways with moderate cracking. This treatment has proven to retard reflective cracking in Australia's wet and dry no-freeze climates. In addition to the geotextile, it is believed that modified binders, including crumb rubber, aid in the retardation of reflective cracking. (See Technical Bulletin 38 for specifications, geotextile type and thickness, type of tack coat, additives, etc.).

This treatment has also been used directly on subgrade and has been very successful in retarding damage to this material, provided no traffic is allowed during saturated conditions.

Recommendation: Agencies that do not use modified binders for chip seals should be encouraged to do so.

Quality chip seals exhibiting long service life use bitumen modified with a variety of products. The predominate modifiers are SBS (extensively) and crumb rubber (to a lesser degree). A unique application used in France and Australia that deserves evaluation is the use of fibers applied directly on the bitumen before the application of the cover aggregate. The fibers enhance both aggregate retention and treatment performance.

Recommendation: Encourage agencies to review their specifications and upgrade them where appropriate so that superior aggregates are used and improved service life is accomplished.

The success of chip seals in all the countries visited is due in large part to the high quality of the aggregate and the emphasis placed on design. High quality aggregate (clean, <0.05% passing the –200; low LA abrasion (<15); low micro-duval (<20)) of a single size is routinely used. In many instances, aggregate is hauled great distances (>500 km). In addition, application rates are optimized for the type of aggregate and bitumen used.

Recommendation: Encourage agencies to review their design practices for chip seals and consider placing them on base or subbase courses to prevent moisture infiltration.

To prevent moisture infiltration and capillary action, the Australians often place a chip seal on the base or subbase prior to placing the asphalt surface. This technique is especially useful on highly moisture susceptible bases and subbases. The Australians also perform designs to optimize application rates for the type and gradation/grade of aggregates and bitumen used.

Timely Preventive Maintenance

Recommendation: Chip seals should be applied earlier in the distress cycle.

All countries visited tried to detect cracking in the 1-3 mm range, at which time a chip seal would be applied. The typical US treatment is to wait for a visible cracks to appear (4 mm or greater) before applying a crack seal. Often, only after several years of crack sealing is a chip seal applied in the US. Applying a chip seal earlier in the distress cycle would prevent water infiltration into the base and thus deter premature pavement failure. This approach may extend the life of roadway pavement structures and reduce the need for expensive rehabilitation projects.

Recommendation: The successful practice in New South Wales of placing thin (40-60 mm) asphalt overlays on PCC should be investigated.

Placing thin overlays on PCC pavement has not been very successful in the United States. The Australians have designed a system specifically for this application that may provide additional preservation options for PCC pavements in the United States. In Australia, the PCC is cured with a hydrocarbon compound followed by the application of a tack coat in the normal manner.

Innovative Methods, Practices and Procedures

Recommendation: AASHTO and FHWA should develop a mechanism to evaluate and implement new and innovative products and processes.

A new, national, institutional process needs to be established in order to foster and manage innovation. This process needs to include proprietary products that private sector investment has developed and should also consider the concept of "risk sharing" as exemplified by the French "Charter of Innovation" system. This would encourage innovation by giving contractors/suppliers greater opportunities to market new technology.

Contract Maintenance

Recommendation: AASHTO and/or FHWA should conduct a seminar to share best practices and also investigate the possibility of demonstration projects in the United States using long-term maintenance contracts.

Contracting or outsourcing maintenance activities has moved to long-term contracts of 3 to 10-year periods for various types of "total maintenance". These contracts are monitored for performance by means of various asset management techniques. Additional evaluation of the associated benefits for such long-term contracts regarding pavement preservation is needed.

Pavement Condition Survey Equipment

Recommendation: An investigation of Road Crack? and similar vehicles be conducted to fully evaluate the potential for use by transportation agencies. And, if warranted, a pilot program be developed for a side-by-side field evaluation of these vehicles

Early and accurate detection of pavement distresses is essential for an effective pavement preventive maintenance program. Transportation agencies in the US invest significant amounts of resources in the collection of road condition information. Transportation agencies are in constant search of more efficient and cost-effective ways

of collecting this information. In the State of New South Wales, the team was made aware of a high-speed pavement condition survey vehicle capable of detecting pavement cracks as small as one mm in width. The Road Transportation Authority (RTA) of New South Wales has developed the Road Crack? vehicle that meets this need. This vehicle has the potential of saving significant resources in transportation agencies throughout the US and other countries.

IMPLEMENTATION

A small group of the scanning team members has been formed to develop a technology implementation plan that will outline a series of activities to document, showcase, apply and evaluate the innovative pavement preservation techniques, processes, materials and equipment utilized in the tour hosting nations. These activities will be directed to educate and demonstrate to the United States highway community the effectiveness and value of these innovative technologies.